NAS Brunswick Groundwater Extraction & Treatment System: A Practical Approach to Sustainable Remediation

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Overview

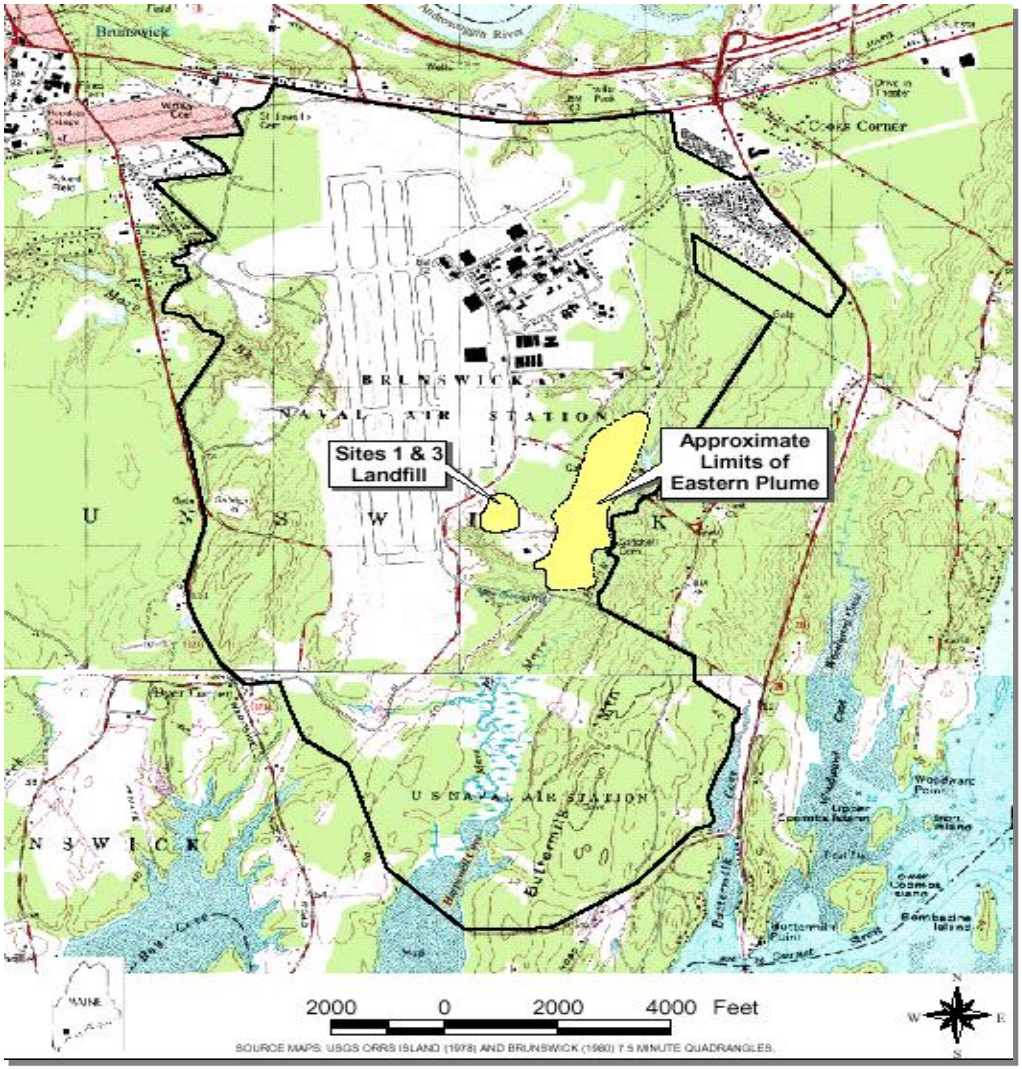
- Groundwater Extraction & Treatment System (GWETS) has been operating at NAS Brunswick for over 15 years
- Navy Team has aggressively sought opportunities to enhance sustainability of remedial operations while protecting human health and the environment
- Enhancements (current and proposed) have included:

  - On-site recycling of GWETS effluent to infiltration gallery

  - Power consumption analysis to minimize environmental footprint and develop more energy efficient treatment train

  - Continued evolvement and update of site conceptual model and associated risk assessment analysis to support long term strategies and decision making

Naval Air Station Brunswick GWETS –
A Practical Approach to Sustainable Remediation



- **NAS Brunswick located on Maine's southern coast.**
- **Supported the Navy's antisubmarine warfare operations from 1940s to 2010.**
- **Identified for Base Closure in 2011 in accordance with 2005 BRAC law.**
- **Now in final stages of BRAC process, property to be transferred back to public.**
- **Residual contamination being mitigated under the Navy's Installation Restoration Program.**

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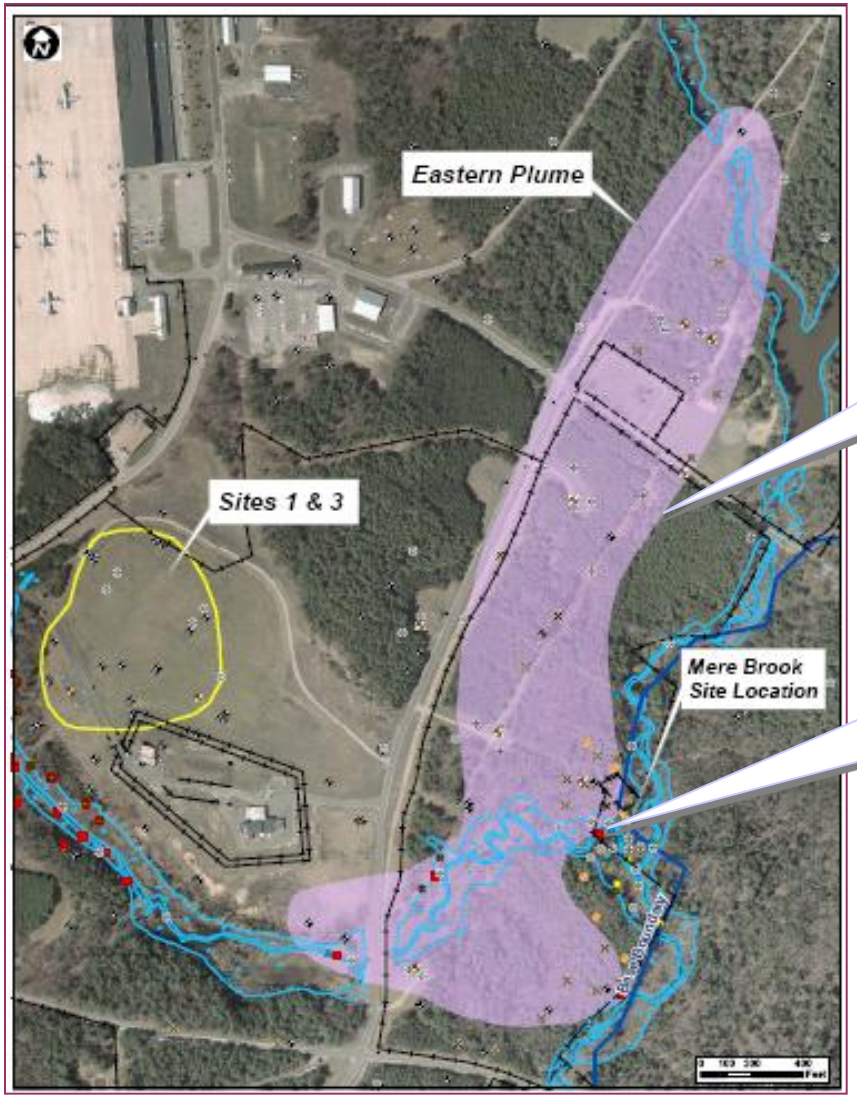
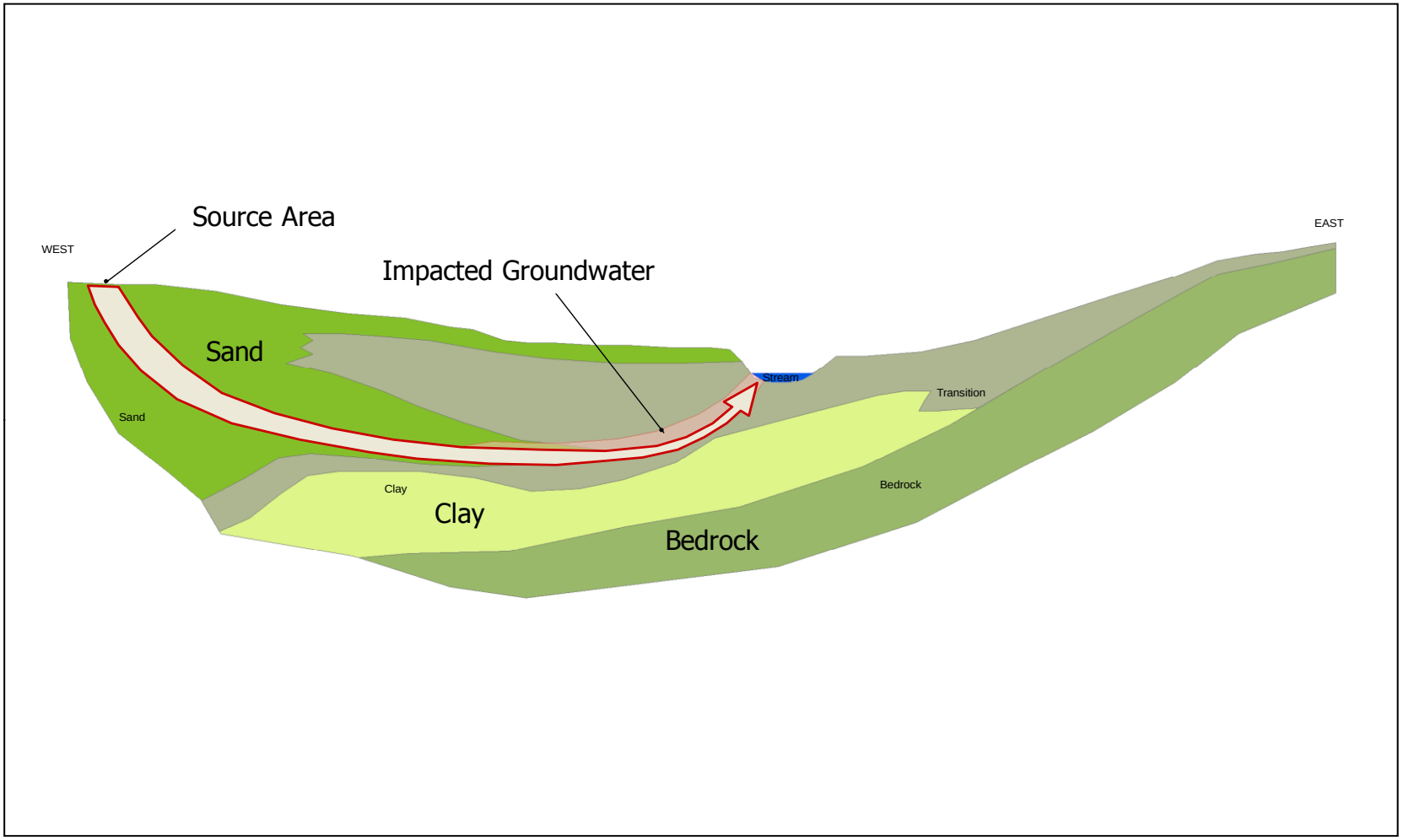


Eastern Plume is hydraulically contained by clay aquitard overlying bedrock

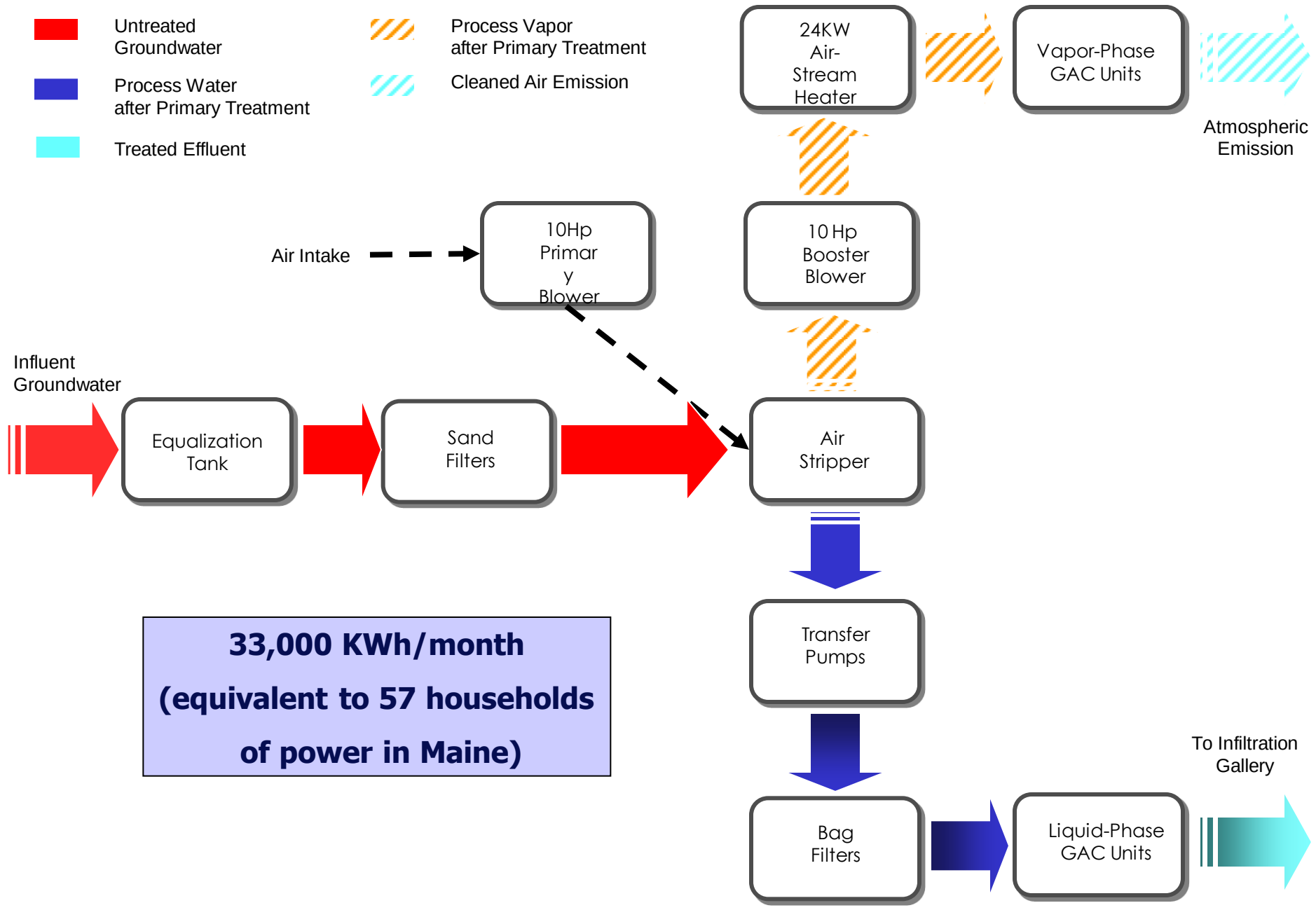
However, groundwater upwells and discharges along several areas of Mere Brook

Groundwater Contaminant Migration Route



GWETS at Building 50

GWETS Operational Schematic



Plume Reduction Since 1995

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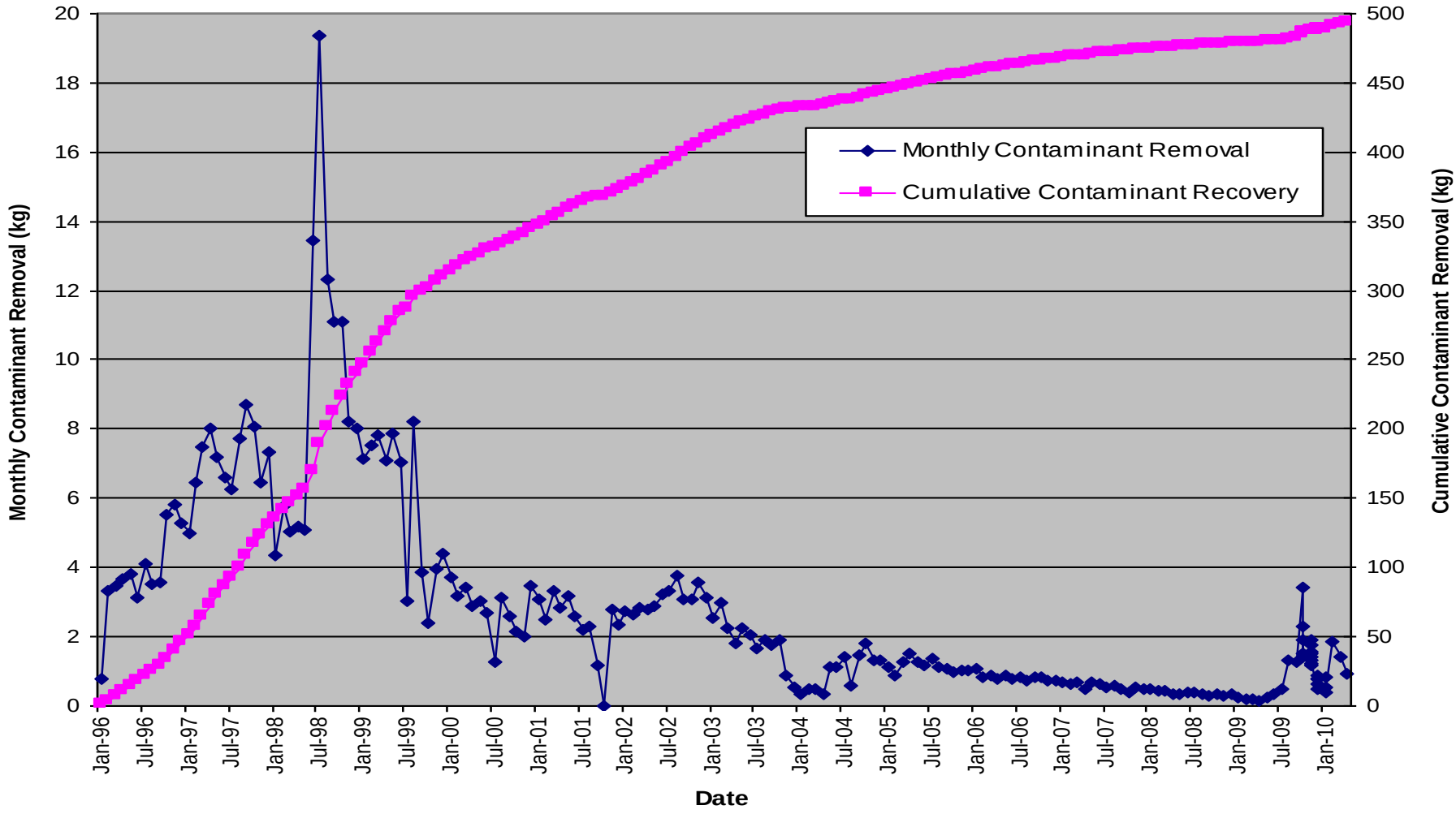
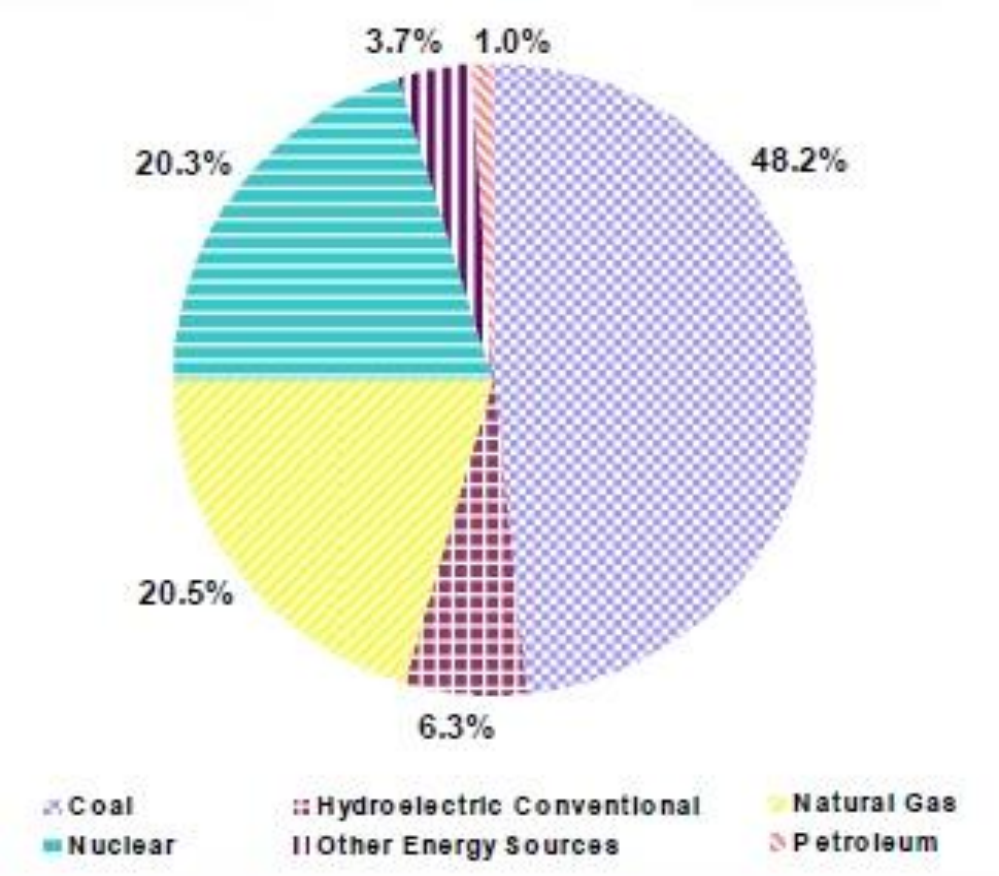


Back Diffusion Problem

GWETS Performance Summary

- Very effective for hydraulic control and contaminant recovery during first 10 years
- Diminishing effectiveness since 2005, GWETS operations have reached asymptotic range
- Further contaminant recovery is diffusion-limited
- Eastern Plume chlorinated solvent concentrations substantially reduced, although residual impacts continue to exceed site closure requirements
- Several decades may be required to reach site closure using diffusion-limited pumping
- What are the off-site environmental impacts incurred during GWETS operation?

USA Electrical Generation by Energy Source – All Sectors
(effective February 2010, not specific to NASB)



Annual Off-site Air Emissions Relative to Chlorinated Solvent Recovery

Total Annual Emissions for Conventional Sources of GWETS Electrical Demand*	
Sulfur Oxides (SOx)	3,893 lbs
Nitrogen Oxides (NOx)	2,007 lbs
Carbon Monoxide (CO)	71 lbs
Fine Particulates	3,785 lbs
Mercury	151 lbs
Carbon Dioxide (CO_2)	558,407 lbs

Asymptotic GWETS Chlorinated Solvent Recovery = 10-12 lbs per year.

*** 20% of power provided by nuclear sources not included, generation breakdown typical for USA (not specific to NASB)**

Previously Completed Energy Efficiency Measures

1) Primary treatment changed from Metals Removal and UV Oxidation to Air-Stripping and Granular Activated Carbon (GAC)

- Substantial reduction in power usage

2) On-site infiltration gallery installed to accept treated effluent, reducing load on Brunswick Sewer System by 50,000-gal/day

- Eliminated sewer pumping and secondary wastewater treatment

Infiltration Gallery

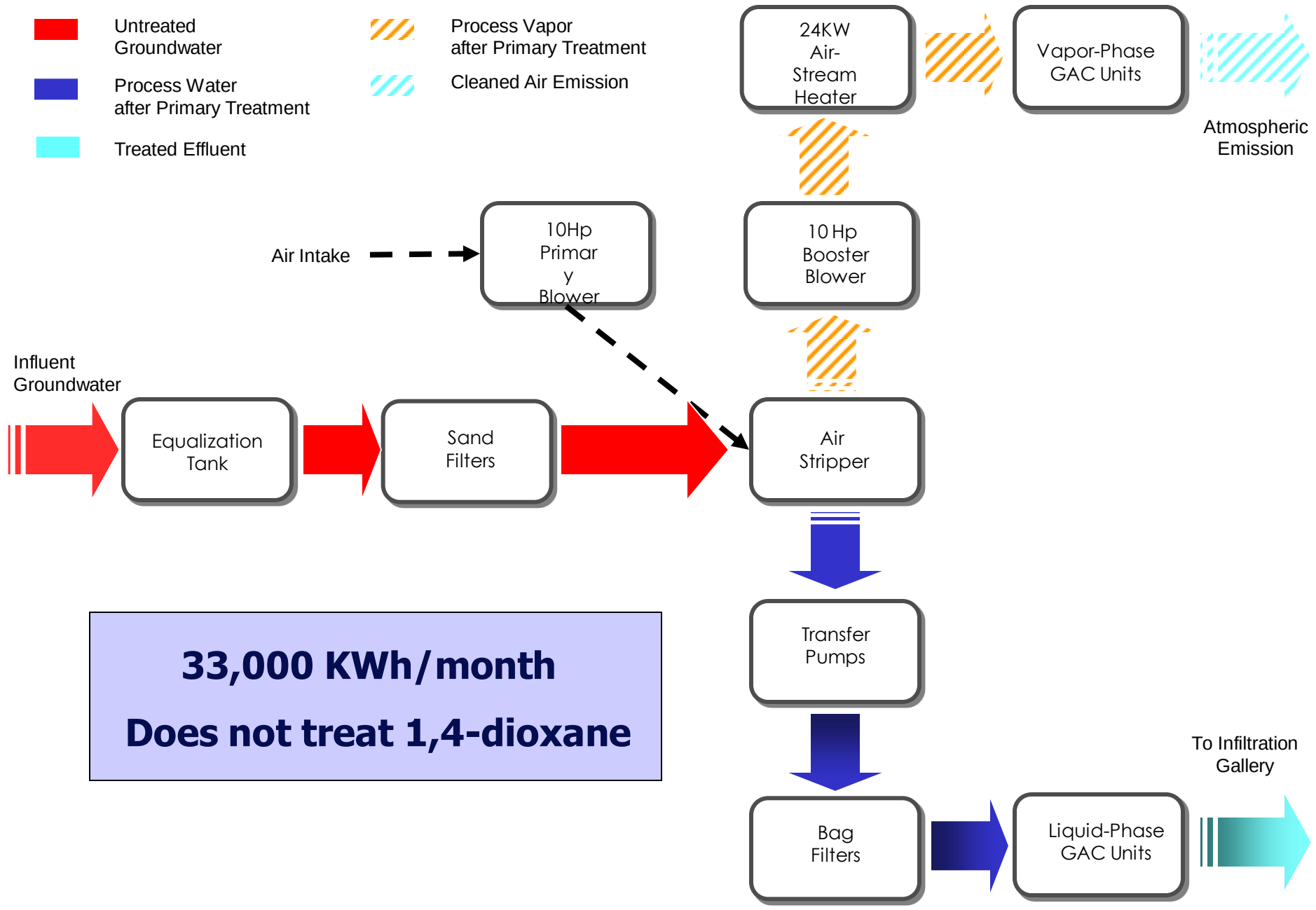
- Onsite subsurface crushed stone infiltration system, gravity fed
- Recharges approximately 25 million gallons per year into local aquifer – reduces load on local POTW
- Requires very little maintenance
- Is consistent with Low Impact Development (LID) initiatives

Two Technical Challenges in 2009

1) Reduce GWETS electrical demand in consideration of off-site environmental impacts

2) 1,4-dioxane: emerging groundwater contaminant not treated by existing air-stripper and GAC system

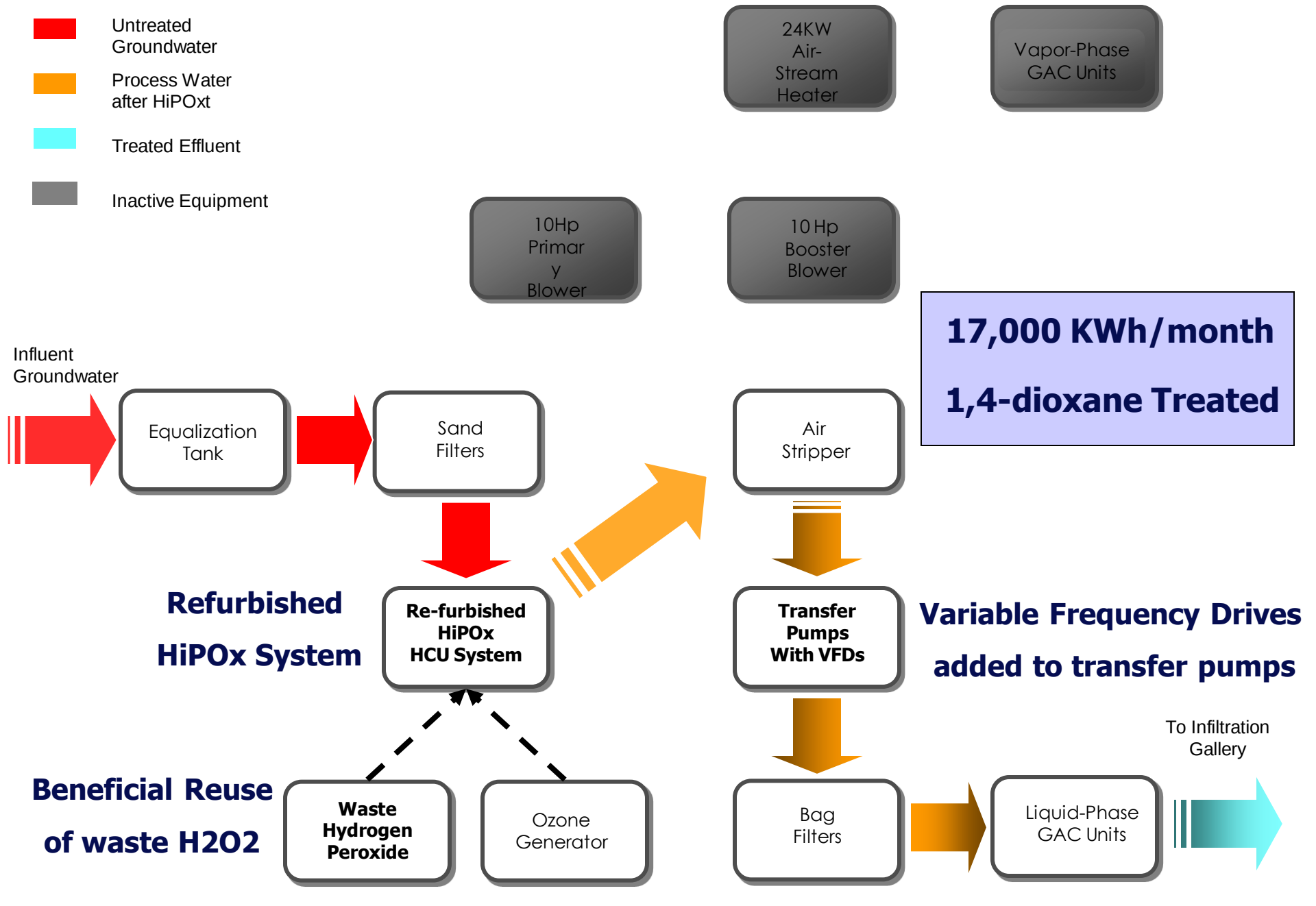
GWETS with Air-Stripper and GAC



33,000 KWh/month

Does not treat 1,4-dioxane

GWETS with HiPOx and Liquid-Phase GAC



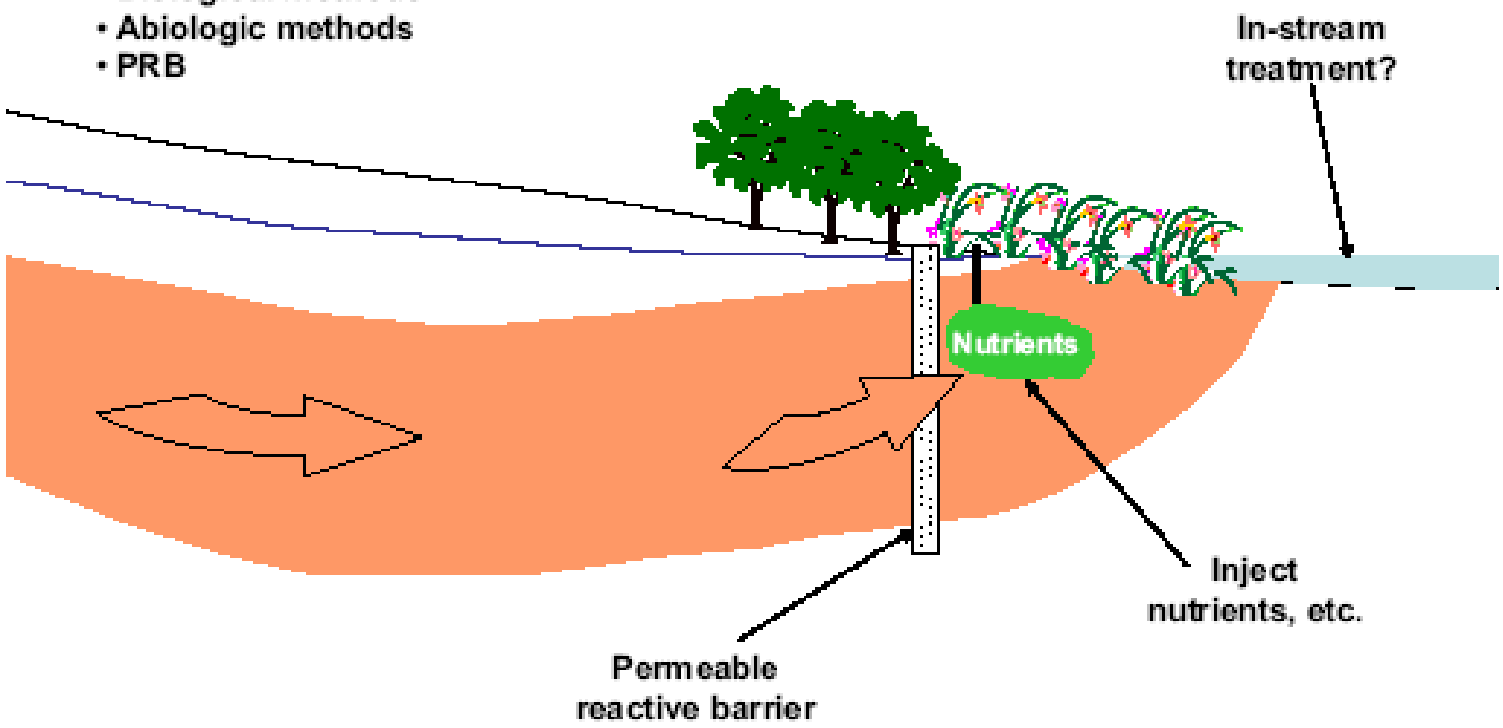
Need for Transition to Sustainable Remediation

- Contaminant mass recovery by GWETS is returning to asymptotic conditions, further removal is diffusion-limited
- Although significantly reduced, residual chlorinated solvent concentrations continue to exceed regulatory standards
- Off-site (i.e., global) environmental impacts associated with electrical power generation for GWETS operation has an impact on regional environmental quality
- Navy continuing to investigate nearby surface water area (Mere Brook) to assess the natural or enhanced attenuation capacity

Sustainable Alternatives to Groundwater Pumping

Reduce mass flux of contaminants at GW-SW interface

- Plant-based methods
- Biological methods
- Abiologic methods
- PRB



Groundwater Discharge Area at Mere Brook

Summary

- Overall environmental footprint should be evaluated at the early stages of remedial design
- Energy audit of remediation system and associated building infrastructure can result in significant long-term savings in power consumption costs
- Off-site environmental impacts incurred during power production for energy-intensive remedial systems should be considered as part of overall environmental strategy
- Further understanding and demonstration of natural attenuation mechanisms along with updated site conceptual model are critical to support best sustainable remedial alternatives for groundwater solvent plumes

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